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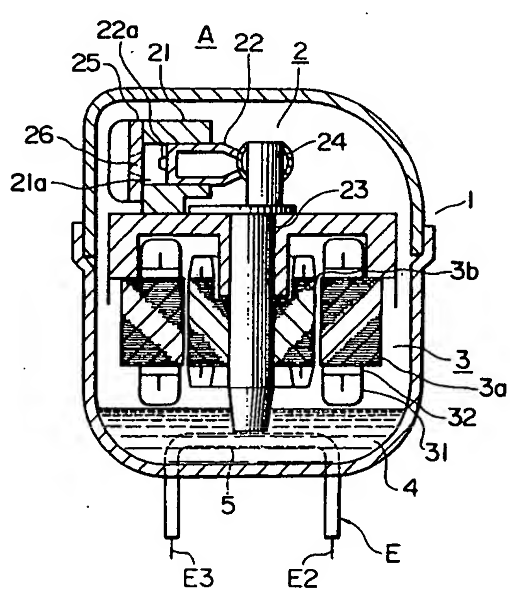
(54) Sealed type compressor.

(57) A compressor for use in a refrigerating cycle operated with R134a as the refrigerant gas includes a reciprocating piston type compressing mechanism (2) disposed in a sealed container (1) and an electric motor for driving the compressing mechanism. The bottom portion of the container forms an oil reservoir for accumulating lubricating oil (4). The oil reservoir is provided with a cooling device (5) which cools the lubricating oil in the oil reservoir to thereby suppress the deterioration of the lubricating performance of the lubricating oil due to the R134a and that of the insulating material of the coil of the electric motor or the like, whereby the reliability of the operation of the compressor can be improved.

FIG. 1



EP 0 513 475 A2

BACKGROUND OF THE INVENTION

The present invention relates to a sealed type compressor and, more particularly, to a sealed compressor which exhibits improved reliability and performance in a case where it is operated with alternate refrigerant R134a which meets the freon (fluorocarbon) regulation.

Recently, the use of chloride type freon has been regulated because of the problem of the ozone destruction. For example, the use of freon 12 (R12), which has been used in the refrigeration cycle of a refrigerating apparatus such as a refrigerator, is regulated. Therefore, R134a tends to be used as an alternate refrigerant.

First, a conventional sealed type compressor will now be described with reference to Figs. 7 and 8.

As shown in Fig. 7, a reciprocating compressor A, which belongs to the sealed compressors for use in refrigerators, freezing chambers or air conditioning apparatuses, has a compressing mechanism 2 and an electric motor 3 both accommodated in a sealed container 1. Furthermore, refrigerator or lubricant oil 4 is contained in the bottom portion of the sealed container 1. In addition, a piston 22 is slidably disposed in a cylinder 21 of the compressing mechanism 2. The piston 22 thus disposed is reciprocated by the eccentric rotation of an eccentric portion 24 of a crank shaft 23 which transmits the rotational force of the electric motor 3. As a result, the refrigerant gas can be sucked, compressed and discharged.

The refrigerant compressed by the compressing mechanism 2 and discharged from the compressor A is at a high temperature and under a high pressure. Therefore, the refrigerant gas radiates heat and is liquefied when it passes through a condensor B formed by a zigzag pipe as shown in Fig. 8. The pressure of the liquefied refrigerant is lowered by a pressure-reducing mechanism C comprising a capillary tube before it is introduced into an evaporator D. During the passage of the refrigerant through the evaporator D, it is evaporated while absorbing heat of the portion outside the evaporator D. As a result, it is again reformed into a low temperature and low pressure gas and then sucked by the compressor A.

In the above-described conventional sealed compressor, R12, R22, or R502 or the like is used as the refrigerant. The temperature at which the sealed compressor is operated, the material of each of the elements of the movable portions and the volume of the cylinder and the like have been determined in consideration of the type of the refrigerant employed. Therefore, in a case where R134a is used as the alternate refrigerant, a problem is predicted that the reliability at the temperature at which the conventional compressor has been operated. The reason for this lies in the degradation of the refrigerating machine oil (lubricating oil), the lubricating performance thereof, and the stability of the material of an enameled wire 31 and that of an insulating member 32, for example, deterioration in the facility in origomer extraction. In the case in which R134a is used, there arises another problem that the size of the compressor must be increased because of a necessity for enlarging the volume of the cylinder because the refrigerating performance obtainable from the same cylinder volume is lowered due to the thermal property of R134a in comparison to a case in which another refrigerant is used.

Accordingly, an object of the present invention is to provide a sealed type compressor which is capable of overcoming the above-described problems, designed to use R134a which does not destruct ozone and displays reliability and performance comparable to those obtained in the case in which R12 is used.

The sealed compressor according to the present invention is used in a refrigeration cycle in which R134a is used as the refrigerant gas. The basic structure of the compressor comprises a sealed container, a reciprocating piston type compressing mechanism disposed in the container and an electric motor for driving the compressing mechanism. The bottom portion of the container forms an oil reservoir for accumulating lubricating oil. Furthermore, the present invention is characterized in that the oil reservoir is provided with a cooling device.

The cooling device cools the lubricating oil in the oil reservoir to lower the temperature of the discharged gas from the compressor and that of the coil of the electric motor below the temperatures realized in a case where the compressor uses refrigerant R12. therefore, deterioration of the lubricating oil (refrigerator oil) can be prevented. Furthermore, the quantity of origomer extracted from the enamel wire and the insulating member which are exposed to refrigerant. R134a can be the same or smaller than that obtained in the case in which they are exposed to refrigerant R12.

In an embodiment of the present invention, the refrigeration cycle includes a condenser for condensing the refrigerant gas discharged from the compressing mechanism and an evaporator for evaporating the condensed refrigerant. The condenser includes a first portion adjacent to the compressing mechanism and a second portion adjacent to the evaporator. The cooling device is disposed in the oil reservoir and has its inlet and outlet ports respectively connected to an outlet port of the first portion of the condenser and an inlet port of the second portion of the same, so that the refrigerant,

which has passed through the first portion of the condenser, flows in a heat exchange relationship with the lubricating oil in the oil reservoir to cool the lubricating oil and, then, is introduced into the second portion of the condenser.

In the embodiment of the present invention, a manganese phosphate layer is formed in at least a portion of the surface of a crank shaft which connects the compressing mechanism with the electric motor. Preferably, a molybdenum disulfide sprayed layer may be formed on the manganese phosphate layer. Since the compression ratio in the case where refrigerant R134a is used is higher than in the case where refrigerant R12, the frictional forces acting on the surface of the crank shaft and the surface of the piston, which are sliding surfaces of the compressing mechanism, are larger in the case where R134a is used. The manganese phosphate layer and the molybdenum disulfide sprayed layer improve the self-lubricating performance of the sliding surfaces. Therefore, even when R134a is used, the reliability of the operation of the moving portions can be kept for a long time.

It is further preferred that the compressing mechanism includes a cylinder head having a discharge port formed at a position which confronts the head of the piston and the head of the piston has a projection at a position aligned with the discharge port of the cylinder head, so that the projection is received by the discharge port when the piston reaches its top dead center. As a result, the re-expansion loss due to the dead volume of the discharge port can be reduced to improve the volumetric efficiency.

The above and after objects, features and advantages of the invention will become more apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a vertical cross sectional view of a sealed compressor embodying the present invention;

Fig. 2 is a block diagram which illustrates a refrigeration cycle which includes the compressor shown in Fig. 1;

Fig. 3 is a graph which shows the results of experiments for evaluating the deterioration in the lubricating oils in a case where refrigerant R12 is used and in another case where refrigerant R134a is used;

Fig. 4 is a graph which shows the results of experiments for evaluating the degree of oligomer extraction from an enamel wire and an insulating member in a case where refrigerant R12 is used and in another case where refrigerant R134a is used;

Fig. 5 is an exaggerated and enlarged view of a part of the surface of a crank shaft covered with a manganese phosphate layer;

Fig. 6 is an exaggerated and enlarged view which illustrates a molybdenum disulfide layer formed on the manganese phosphate layer by a spraying method; and

Figs. 7 and 8 respectively correspond to Figs. 1 and 2 and illustrate the conventional compressor discussed above.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1 and 2, the elements which are the same as those shown in Figs. 7 and 8 are given the same reference numerals.

A sealed compressor A is designed to be used with R134a to cool a refrigerator and has a sealed container 1 of a metal. The container 1 accommodates compressing mechanism 2 and electric motor 3 which are drivingly connected to each other by a crank shaft 23. The electric motor 3 has a stator 3a which has a coil 31 wound around a stator core via an insulating material 32. A rotor 3b of the electric motor 3 is secured to an end portion of the crank shaft 23 for rotation therewith. The compressing mechanism 2 has a cylinder 21 and a piston 22 which is reciprocally disposed in the cylinder bore in the cylinder 21. The piston 22 is connected to an eccentric portion 24 of the crank shaft 23 so as to be driven in such a manner that it is reciprocated in the cylinder 21. A cylinder head 25 forms a closed working-chamber 21a in cooperation with the cylinder 21 and the piston 22. The volume of the working chamber 21a is changed when the piston 22 is reciprocated. The cylinder head 25 has a discharge port 26 formed at a position which confronts the head of the piston 22. On the other hand, a projection 22a is formed on the head of the piston 22 so that the projection 22a is received into the discharge port 26 when the piston 22 reaches its top dead center.

The bottom portion of the sealed container 1 forms an oil reservoir 4 for accumulating lubricating oil (also called "refrigerator oil") for lubricating movable portions of the compressing mechanism 2 such as the eccentric portion 24 and the peripheral surface of the piston 22. The lubricating oil accumulated in the oil reservoir 4 is, by a known oil circulating mechanism (omitted from illustration), forcibly sent to the above-described movable portions so that they are lubricated. Then, the lubricating oil flows along the stator 3a of the electric motor 3 to cool the coil 31 and the insulating member 32 of the stator 3a and then drops and returns to the oil reservoir 4.

The cylinder head 26 has a suction port (omitted from illustration) in addition to the dis-

charge port 26. The discharge port 26 and the suction port are connected to a refrigeration cycle as shown in Fig. 2. The reciprocating motion of the piston 22 changes the volume of the working chamber 21a, causing the working chamber 21a to suck the refrigerant R134a, compress the same and discharge the same.

As in the conventional refrigeration cycle, the refrigeration cycle shown in fig. 2 comprises a condenser B for receiving high temperature and high pressure refrigerant gas discharged from the compressor A to condense it, a pressure reducing mechanism C for reducing the pressure of the condensed refrigerant and formed by a capillary tube and an evaporator D for evaporating the refrigerant the pressure of which has been reduced, to cause it to absorb heat of circumambient air. In addition to the above-described elements, the refrigeration cycle shown in Fig. 2 has a modification to be described below:

The oil reservoir 4 shown in Fig. 1 has a lubricating oil cooling device E which includes a pipe 5 which extends through the lubricating oil accumulated in the oil reservoir 4. The condenser B shown in Fig. 2 includes a first portion, that is, an upstream portion B1, which has an inlet port E1 connected to the discharge port of the compressing mechanism 2. The condenser B further includes a second portion, that is, a downstream portion B2, which has an outlet port E4 connected to the pressure reducing mechanism C. The end portions of the pipe 5 shown in fig. 1 are respectively connected to the outlet port E2 of the first portion B1 and the inlet port E3 of the second portion B2 of the condenser B. As a result, the refrigerant gas discharged from the compressor A passes first through the first portion B1 of the condenser B, then, through the pipe 5 of the cooling device E and then through the second portion B2 of the condenser B. Then, the gas is introduced into the pressure reducing mechanism C and passes through the refrigeration cycle in the above-described sequential order. Thus, the refrigerant gas returns to the compressor A.

In the refrigeration cycle for a refrigerator which uses a conventional reciprocating piston compressor (a 250-litter-class reciprocating piston compressor the nominal output of which is 100 W) which does not have the cooling device E shown in Fig. 2, the temperature of the lubricating oil in the compressor reaches 90°C to 100°C. On the other hand, the temperature, at which the refrigerant gas discharged from the compressor is condensed, is set to be of the order of 40°C to 50°C. The refrigerant present in the outlet port E2 of the first portion B1 of the condenser B is in a state in which gas and liquid are mixed with each other. Therefore, when the refrigerant in the above-described state passes through the pipe 5 of the cooling device E, it exchanges heat with the lubricating oil in the oil reservoir 4 and absorbs heat from the lubricating oil to lower the temperature of the lubricating oil. Since the thus cooled lubricating oil is supplied to the moving portions of the compressing mechanism, the compressing mechanism is lubricated and as well as cooled down. Furthermore, the lubricating oil, which has performed the lubricating operation, cools down the electric motor 3.

The temperature of the refrigerant, which passes through the pipe 5 of the cooling device, can be changed by adjusting the position at which the pipe 5 is connected to the condenser B to thereby change the ratio of the gas to the liquid of the refrigerant which is introduced into the pipe 5 of the cooling device. In the embodiment shown in Fig. 2, the pipe 5 is connected to an intermediate portion (the intermediate portion in terms of the heat capacity) of the condenser B. As a result, it was found that the temperature (the temperature of the discharged refrigerant gas and that of the coil 31 of the electric motor 3) of the compressor A having the above-described capacity is lowered by about 10°C to 15°C as compared with the conventional compressor which does not have the cooling device E.

Fig. 3 illustrates the results of measurements of the degree of deterioration in the lubricating oil with respect to the time while compressors were operated, the measurement being carried out by means of the chromaticity. Referring to Fig. 3, the two solid line curves X and Y show the results measured when the compressor was operated with the refrigerant R134a, while the broken line curve line Z shows the results measured when the compressor was operated with the refrigerant R12. Curves X and Z respectively show the results obtained in the cases where the compressors had not the lubricating oil cooling device E and were operated with the refrigerant R134a and with the refrigerant R12 and both at the same operation temperature (the conventional operation temperature set for use with R12). On the other hand, the curve Y shows the result obtained in the case where the compressor had the lubricating oil cooling device E and was operated with the refrigerant R134a. As can be seen from the curves X, Y and Z, even if the refrigerant R134a is used, the compressor having the lubricating oil cooling device E according to the present invention exhibits a deterioration in the lubricating oil substantially equal to the deterioration in the lubricating oil experienced with the conventional compressor having no lubricating oil cooling device and operated with the refrigerant R12.

Fig. 4 illustrates the results of measurements of

the quantity of extracted origomer from the enamel wire 31 and that from the insulating member 32 with respect to the time (days) while the compressor was operated. Referring to Fig. 4, the two solid line curves x and y show the results obtained when compressors were both operated with the refrigerant R134a, while the broken line curve z shows the results obtained when a compressor was operated with the refrigerant R12. Curves x and z respectively show the results obtained in the case where the compressors which had not the lubricating oil cooling device E and operated respectively with refrigerant R134a and with the refrigerant R12 and both at the same operation temperature (the conventional operation temperature set for R12). On the other hand, the curve y shows the result obtained in the case where the compressor had the lubricating oil cooling device E, and operated with the refrigerant R134a. As can be seen from the curves x, y and z, the compressor having the lubricating oil cooling device E according to the present invention exhibits thew extracted origomer quantity y which is smaller than the extracted origomer quantity z obtained in the case where the conventional compressor having no lubricating oil cooling device is operated with the refrigerant R12. Therefore, even if the compressor according to the present invention is operated with the refrigerant R134a, the moving portions of the compressing mechanism can be protected from problems caused due to the action of the origomer deposited from the enamel wire or the insulating member.

The projection 22a formed on the head of the piston 22 reduces the re-expansion loss due to the dead volume of the discharge port 26. Therefore, the volumetric efficiency of the compressor is improved by about 5%. Furthermore, since the whole of the compressor is cooled by the lubricating oil cooling device E and, thus, the temperature of the refrigerant gas contained in the sealed container 1 is lowered by about 10°C, the volumetric efficiency is additionally improved by about 3%. Thus, the total of the volumetric efficiency is improved by 8% because the improvement in the volumetric efficiency realized by the projection 22a of the piston 22 is about 5%, to thereby compensate for the deterioration in the refrigerating performance due to the physical properties of R134a.

Furthermore, referring to Figs. 5 and 6, in the preferred embodiment of the present invention, the sliding surface of each of the piston 22 and the crank shaft 23 has formed thereon a manganese phosphate layer 27 to improve the self-lubricating performance of each of the sliding surfaces. Therefore, the reliability of the operation of the compressing mechanism can be improved. If the manganese phosphate layer 27 is formed only on either the piston 22 or the crank shaft 23, a corresponding effect can also be obtained. In a further preferred embodiment of the present invention, a molybdenum disulfide sprayed layer 28 is formed on the manganese phosphate layer 27, molybdenum disulfide (MoS_2) being a solid lubricant 28a. The molybdenum disulfide sprayed layer 28 is formed in such a manner that a mixture of the solid lubricant 28a and a binder (an epoxy resin or an amidoimide resin) 28b dissolved by a solvent is sprayed onto the surface of the manganese phosphate layer 27. Then, the solvent is perfectly removed by heating, which is performed at about 100°C, so that the molybdenum disulfide sprayed layer 28 is formed. Then, the surface of the molybdenum disulfide sprayed layer 28 is brushed in a specific direction so as to forcibly orient the particles of the solid lubricant 28a. Furthermore, the layer 28 is heated at about 120°C to 150°C so as to polymerize the binder 28b by a thermal setting reaction. The solvent for the amideimide resin may be, for example, N-methylpyrolidone, while the solvent for the epoxy resin may be, for example, a mixture of Cellosolve acetate and methylethylketone. Since the particles of the solid lubricant 28a, which have been forcibly oriented, are oriented in a specific direction, its surface is peeled due to cleavage when frictional force is added to the same. Therefore, it has a very small frictional resistance.

As described above, the present invention provides a reliable and high performance sealed compressor for use with the R134a refrigerant which will not destruct ozone.

Claims

1. A sealed compressor for use in a refrigeration cycle in which R134a is used as a refrigerant gas, said compressor including a sealed container, a reciprocating piston type compressing mechanism disposed in said container and an electric motor disposed in said container and arranged to drive said compressing mechanism, the bottom portion of said container forming an oil reservoir for accumulating a lubricating oil,

   characterized in that a cooling device for cooling the lubricating oil in said oil reservoir is provided.

2. A sealed compressor according to Claim 1, wherein said refrigerating cycle includes a condenser for condensing the refrigerant gas discharged from said compressing mechanism and an evaporator for evaporating the condensed refrigerant, said condenser includes a first portion adjacent to said compressing mechanism and a second portion adjacent to

said evaporator, said cooling device is disposed in said oil reservoir and has inlet and outlet ports respectively connected to an outlet port of said first portion of said condenser and an inlet port of said second portion of said condenser, whereby the refrigerant, which has passed through said first portion of said condenser, flows in a heat exchange relationship with said lubricating oil in said oil reservoir to cool the lubricating oil and then the refrigerant is introduced into said second portion of said consenser.

3. A sealed compressor according to Claim 1 or 2, wherein a manganese phosphate layer is formed in at least a portion of the surface of a crank shaft which connects said compressing mechanism with said electric motor.

4. A sealed compressor according to Claim 3, wherein a molybdenum disulfide sprayed layer is formed on said manganese phosphate layer.

5. A sealed compressor according to Claim 1 or 2, wherein a manganese phosphate layer is formed in at least a portion of the surface of a piston of said compressing mechanism.

6. A sealed compressor according to Claim 5, wherein a molybdenum disulfide sprayed layer is formed on said manganese phosphate layer.

7. A sealed compressor according to Claim 1 or 2, wherein manganese phosphate layers are formed in at least a portion of the surface of a crank shaft which connects said compressing mechanism with said electric motor and in at least a portion of the surface of a piston of said compressing mechanism.

8. A sealed compressor according to Claim 7, wherein a molybdenum disulfide sprayed layer is formed on each of said manganese phosphate layer formed on said surface of said crank shaft and said manganese phosphate layer formed on said surface of said piston.

9. A sealed compressor according to any one of Claims 1 to 8, wherein said compressing mechanism includes a cylinder head having a discharge port formed at a position which confronts a head of the piston and said head of said piston has a projection at a position aligned with said discharge port in said cylinder head so that said projection is received by said discharge port when said piston reaches its top dead center.

10. A refrigerator equipped with a sealed compressor according to any one of Claims 1 to 9.

FIG. 1

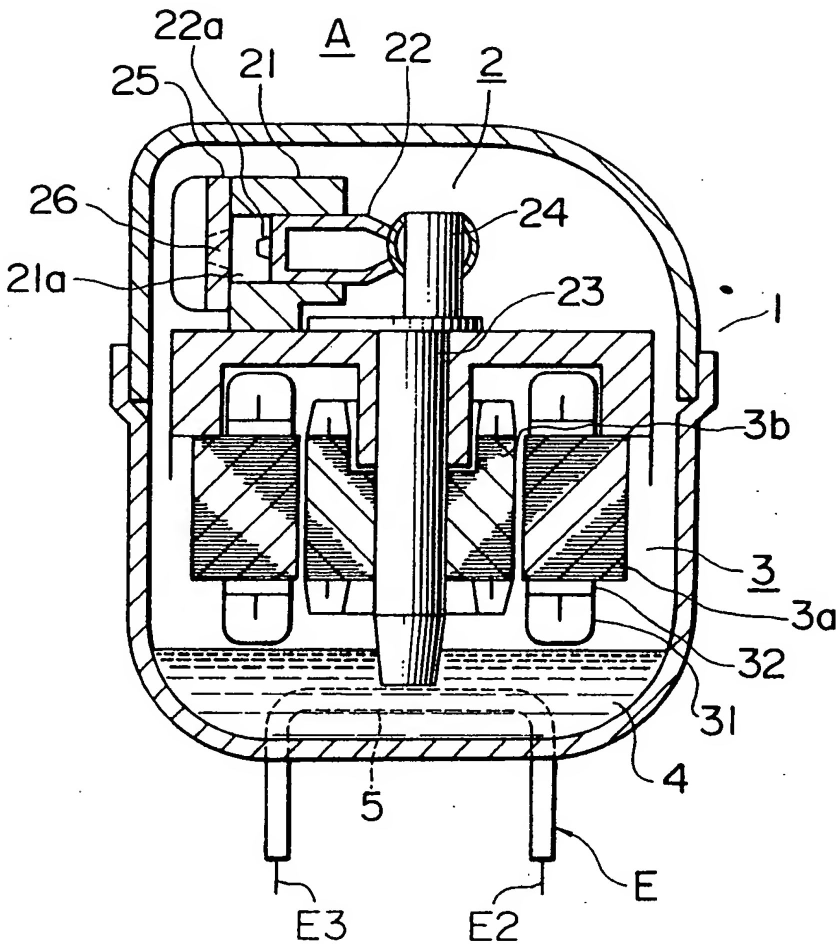


FIG. 2

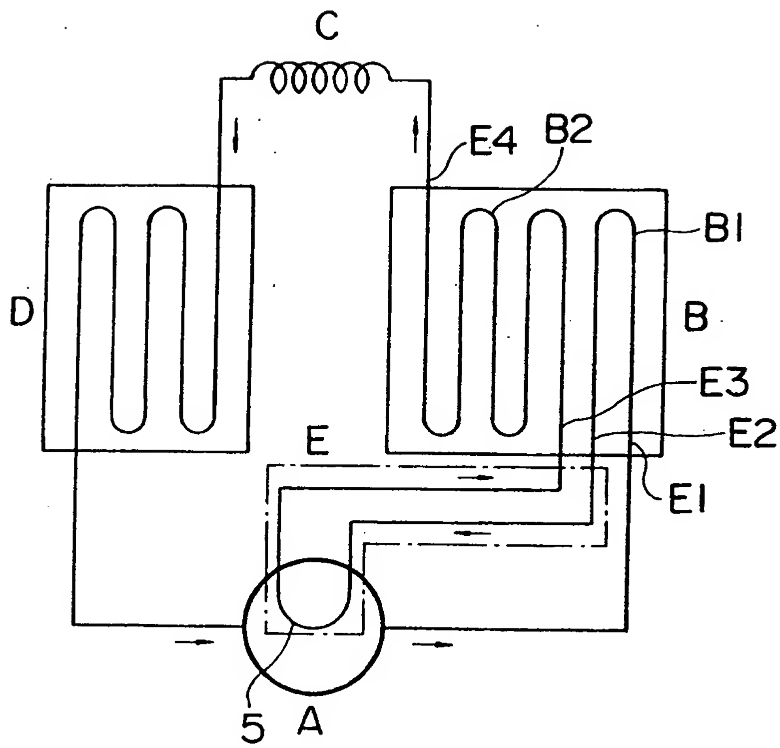


FIG. 3

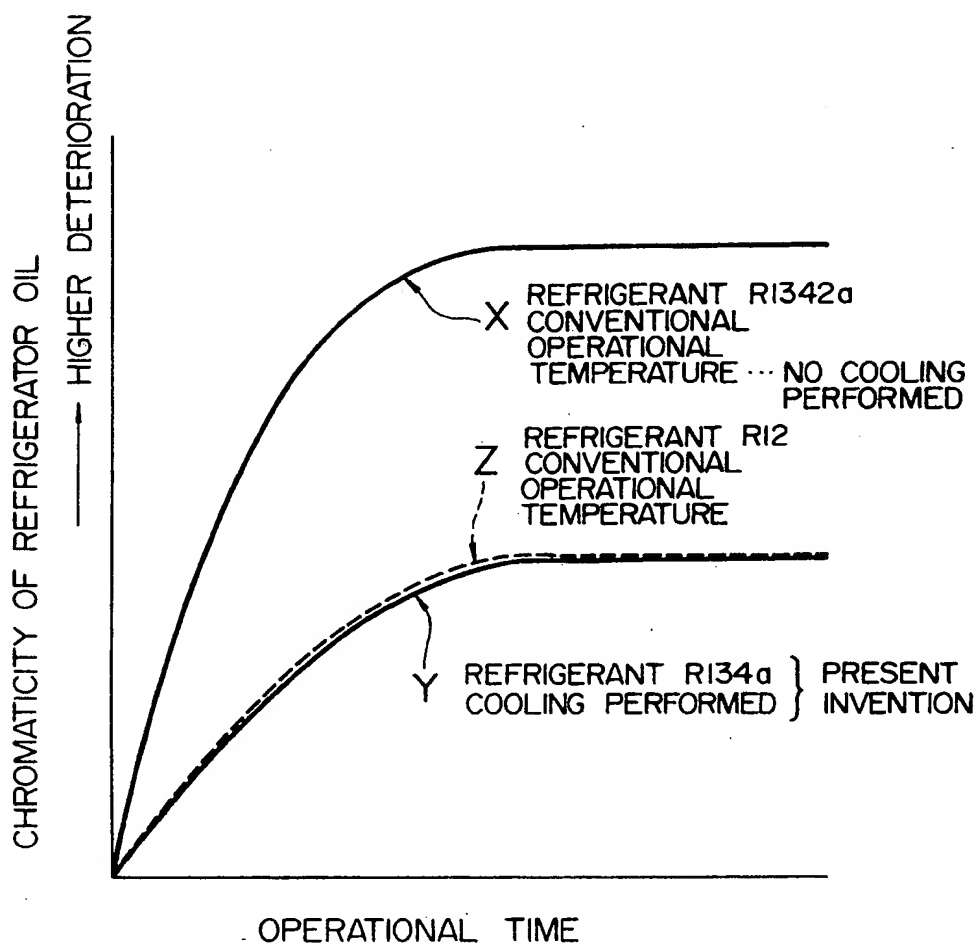
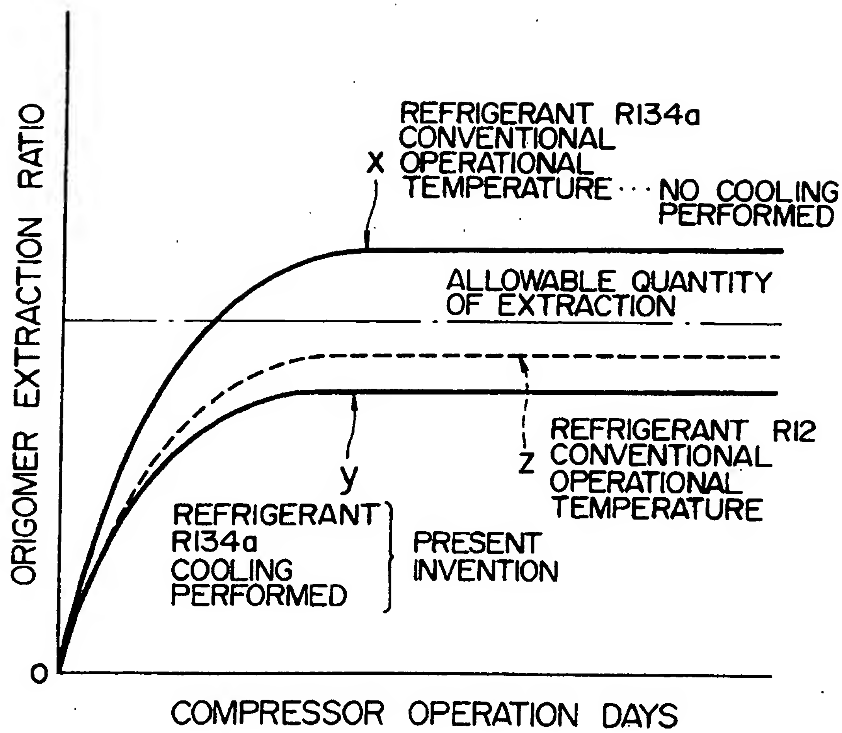

CHROMATICITY OF REFRIGERATOR OIL
→ HIGHER DETERIORATION
X REFRIGERANT R1342a
CONVENTIONAL
OPERATIONAL
TEMPERATURE ··· NO COOLING
PERFORMED
Z REFRIGERANT R12
CONVENTIONAL
OPERATIONAL
TEMPERATURE
Y REFRIGERANT R134a
COOLING PERFORMED
PRESENT
INVENTION
OPERATIONAL TIME

FIG. 4


ORIGOMER EXTRACTION RATIO
REFRIGERANT R134a
CONVENTIONAL
OPERATIONAL
TEMPERATURE ··· NO COOLING PERFORMED
X
ALLOWABLE QUANTITY OF EXTRACTION
REFRIGERANT R12
CONVENTIONAL
OPERATIONAL
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y
REFRIGERANT R134a COOLING PERFORMED
PRESENT INVENTION
0
COMPRESSOR OPERATION DAYS

FIG. 5

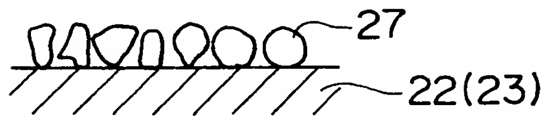


FIG. 6

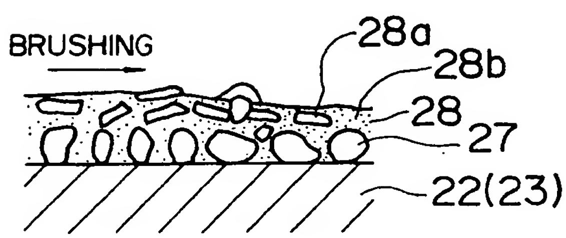


FIG. 7

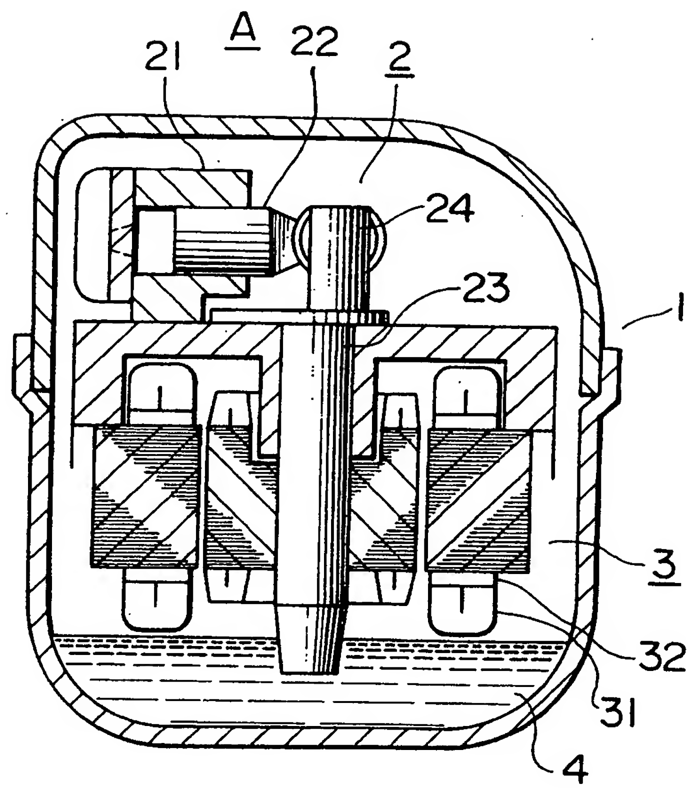
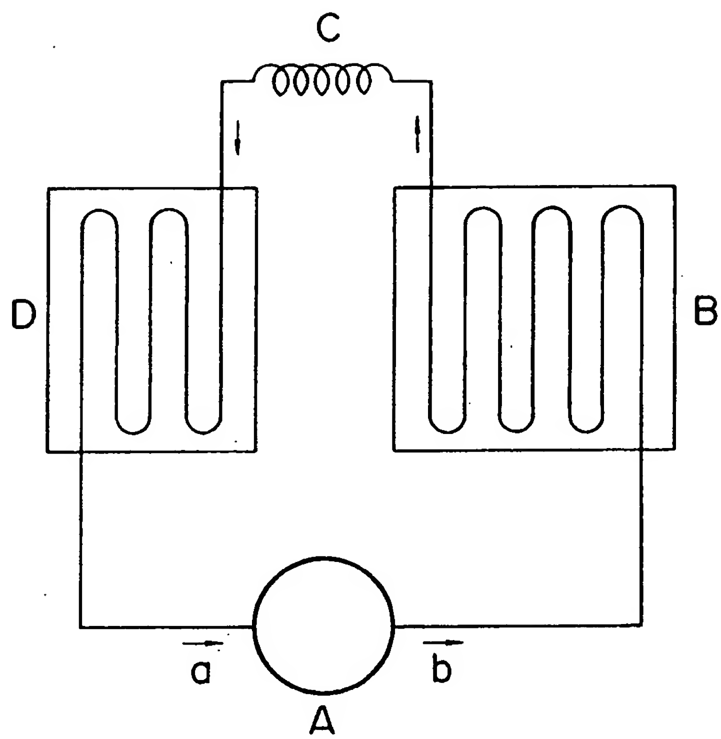


FIG. 8



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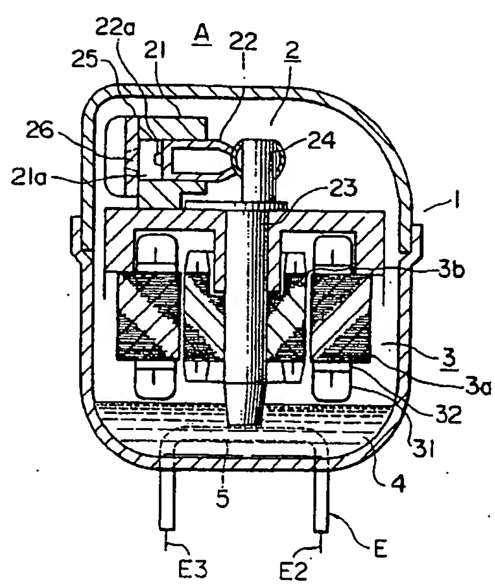
(54) **Sealed type compressor.**

(57) A compressor for use in a refrigerating cycle operated with R134a as the refrigerant gas includes a reciprocating piston type compressing mechanism (2) disposed in a sealed container (1) and an electric motor for driving the compressing mechanism. The bottom portion of the container forms an oil reservoir for accumulating lubricating oil (4). The oil reservoir is provided with a cooling device (5) which cools the lubricating oil in the oil reservoir to thereby suppress the deterioration of the lubricating performance of the lubricating oil due to the R134a and that of the insulating material of the coil of the electric motor or the like, whereby the reliability of the operation of the compressor can be improved.

FIG. 1



EP 0 513 475 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 2316

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 372 404 (VERNEY et al.) * Whole document * ---	1,2,10	F 04 B 39/02 F 04 B 39/00 F 04 B 39/12
X	DE-A-3 902 745 (GOLÜKE) * Whole document * ---	1,2	
A	EP-A-0 438 922 (K.K. TOSHIBA) * Abstract * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F 04 B F 25 B

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-07-1992	VON ARX H.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

European Patent Office

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- [ ] All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- [ ] Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid,

  namely claims:
- [ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions,
namely:

See sheet -B-

- [ ] All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- [ ] Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid.

  namely claims:
- [x] None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

  namely claims: 1,2,10

European Patent Office

EP 92 10 2316 -B-

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1,2,10: A cooling device for cooling the lubricating oil in a sealed compressor.
2. Claims 3-8: A layer for the crank shaft in a sealed compressor.
3. Claim 9: A cylinder head for a sealed compressor.